



# Introduction to Imaging of Penile Prostheses: A Primer for the Radiologist

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**OBJECTIVE.** The purpose of this article is to provide radiologists with an introduction to the imaging appearances of various types of penile prostheses and discuss imaging pitfalls.

**CONCLUSION.** Two major types of penile prostheses currently are in use: malleable penile prostheses and inflatable penile prostheses. Sonography is useful in the assessment of the pelvic reservoir and scrotal pump. MRI helps in the complete evaluation of all the prosthetic components, making it a “one-stop shop” imaging technique.

**M**ale erectile dysfunction (ED) is defined as the inability to achieve or maintain an erection sufficient for satisfactory sexual performance. ED is a highly prevalent condition, with moderate to severe ED having a reported frequency of 5–20% among men [1, 2]. Penile prostheses (PPs), also known as penile implants, are the surgical treatment option for irreversible organic ED. Although patient satisfaction with PP is high, patients must undergo a complex surgery that requires the surgeon to have a high level of expertise and that also carries the risk of catastrophic complications [3–5]. ED is often diagnosed on the basis of the clinical history and a physical examination, with support provided by laboratory analysis and penile Doppler sonography in selected cases to differentiate among various causes of ED [6]. Routine imaging is not currently performed before PP surgery. The detection and management of postoperative complications are challenging, and physical examination alone is difficult to perform and is not accurate in determining the cause of prosthetic dysfunction because findings may be subtle and also because confounding factors, such as scarring from prior surgery and postoperative edema, may exist. Imaging plays a crucial role in determining the position and functional status of the prosthesis and helps in selecting the appropriate treatment: expectant management versus corrective surgery [7–9]. In the present article, we review the imaging of PPs, including current indications for PP, types of PP, and the available imaging armamentarium, with empha-

sis placed on the role of MRI as well as the pitfalls of imaging.

## Approach to Erectile Dysfunction

Erectile function is the result of a complex interplay between vascular, neurologic, hormonal, and psychologic factors. Successful management depends on identifying comorbidities and appropriately addressing psychologic dysfunction. Obtaining detailed sexual, medical, and psychosocial histories, in addition to performing appropriate laboratory tests, is recommended at initial presentation to identify comorbidities predisposing patients to ED [10]. A focused physical examination evaluating the abdomen, penis, testicles, secondary sexual characteristics, and lower extremity pulses is recommended to differentiate ED from closely related abnormalities associated with ejaculation and orgasm. After this information has been obtained, a relevant history of the sexual function of the patient's partner needs to be obtained before available treatment options and their associated risks and benefits are explained [1, 2, 10].

Three stepwise lines of therapy for ED exist, which are progressively invasive and need to be applied one after another to achieve effective management and patient satisfaction [1, 10]. First-line therapy for ED includes the use of oral phosphodiesterase type 5 inhibitors and vacuum constriction devices along with risk factor modifications. If these treatments are not successful, second-line therapy includes the use of intraurethral alprostadil and intracavernous injection of a vasoactive drug. A PP is

## Imaging of Penile Prostheses

a third-line therapy and is indicated when medical therapy is ineffective or contraindicated as well as when vacuum devices are unsatisfactory or unacceptable. Although patient satisfaction with PP is high, it is associated with high costs and the risk of devastating complications. Hence, a PP should be used as the last treatment option after a trial of less invasive and cost-effective medical therapy and vacuum devices [1, 11, 12].

### Indications and Contraindications for Penile Prostheses

The major indications for PP is severe ED that is unresponsive to oral pharmacotherapy and an intracavernous or intraurethral vasoactive agent or when these therapies are contraindicated [11, 13, 14]. Specific indications include Peyronie disease with severe erectile deformity, penile fibrosis, priapism not responding to nonsurgical treatments, phalloplasty after penectomy or sex change surgery, irreversible ED after pelvic surgery, and psychologic impotence after the failure of all other treatments [11, 13–16]. One registry-based database showed that the common indications for a PP include ED resulting from radical prostatectomy for prostate cancer (28% of patients), diabetes (21.6%), cardiovascular disease (19.6%), and Peyronie disease (8.9%) [3].

PP surgery is contraindicated in patients with systemic, cutaneous, or urinary tract infection, to avoid bacterial seeding of the implant during the postoperative healing phase. The patient should be free from dermatitis, wounds, or other cutaneous lesions in the surgical area [17, 18]. Diabetes is one of the common causes of ED, and PP surgery is associated with an increased risk of infection in patients with diabetes. Optimal control of diabetes mellitus may reduce the risk of infection, although the literature is divided on this topic [10]. To avoid infection, it is generally recommended that the blood glucose level be controlled, with a glycosylated hemoglobin level of less than 11.5% recommended before PP surgery is performed. However larger prospective studies and meta-analyses have shown that the infection rate for patients with diabetes is not statistically different from that for the general population undergoing PP implantation [19–21].

### Types of Penile Prostheses

PPs were first introduced in the 1960s by Beheri et al. [22]. Since that time, continuous improvement in the mechanical function of the

devices and the composition of the materials used to reduce the complication rate has occurred. Two major types of PP currently exist.

#### *Malleable or Semirigid Penile Prostheses*

Malleable PPs (MPPs) use simple, noninflatable, paired malleable rods that are surgically placed in each of the corpora cavernosa [14, 16]. Multiple variants made of different material, with or without articulating segments, are available. MPPs usually are made of stainless steel or braided silver core covered in silicone or a coating of polytetrafluoroethylene (Fig. 1). They are surgically easy to insert, have a lower rate of mechanical failure, and are less expensive than IPPs [15]. For patients, the advantage of an MPP is that it is easy manipulated and can be bent in the upward direction before intercourse and in a downward direction when an erection is not needed. An MPP is the preferred PP for patients who do not have the dexterity to manipulate the pump used for an IPP. An MPP is more prone to lateral perforation and distal erosion, especially in patients with reduced sensation, such as patients with spinal cord injury, because of its rigid nature; it is preferentially used when manipulation of the pump of inflatable devices is hampered [23]. Permanent erection caused by the rigidity of the MPP can result in patient discomfort and embarrassment. The MPP currently is less preferred than the inflatable PP (IPP) and is used in less than 10% of patients [1].

#### *Inflatable or Hydraulic Penile Prostheses*

In 1973, introduction of the IPP by Scott et al. [24] was a major breakthrough in PP surgery. There are two types of IPP: a three-piece IPP and a two-piece IPP. The three-piece IPP consists of two inflatable cylinders that are placed within the corpora cavernosa, a pump that is placed in the scrotum, and a reservoir that is placed adjacent to the bladder. All three components are interconnected by silicone tubing and are usually filled with normal saline [17, 25] (Fig. 2). The prosthesis can be activated by squeezing the scrotal pump, which pumps fluid from the reservoir to the cylinders, causing the erection. The two-piece IPP contains the two cylinders and a resipump (a combined pump and reservoir) placed in the scrotum, and it has the advantage of avoiding the need for surgical placement of a reservoir in the pelvis [11]. In addition, an IPP can be either coated or not coated with an antibiotic. An IPP provides the best flaccidity, has rigidity close to

that of natural erection, and offers acceptable cosmetic results and high patient satisfaction [26]. However, these devices are complex and involve multiple components that may lead to more mechanical failures. IPPs also require a difficult surgery that involves placement of the reservoir in the abdomen and the pump in the scrotum; this surgery becomes even more difficult for patients who have undergone prior pelvic surgery [27].

### Role of Imaging Radiography

Conventional radiography was one of the imaging techniques widely used for the visualization of PPs in the era before the introduction of the IPP [28]. MPPs can be visualized with radiography because of their metallic core and mechanical failures like implant fracture can be diagnosed, although they are a rare complication. In the beginning, IPPs were filled with radiopaque contrast media to make them visible on radiographs [29]. Later, after advancements, manufacturers recommended isotonic saline as a better filler, which made IPPs no more visible on plain-film radiographs, except for the metallic component of the rear tip extender (Fig. 3). Moreover, with radiography, only obvious complications like fractures and bucking can be detected, and optimal positioning cannot be ascertained, which makes radiography now obsolete for PP evaluation [9].

#### *Sonography*

Sonography is more useful in making a preoperative diagnosis of ED and in differentiating between various causes of ED, such as vascular causes and Peyronie disease [10]. It is useful in the assessment of types of dysfunction of the reservoir placed in the pelvis, such as blockage, leakage, and migration. The reservoir appears as an anechoic fluid-filled structure in the pelvis close to the urinary bladder. An echogenic structure with its reverberation artifact can be seen along the periphery of the reservoir, representing the internal check-valve apparatus [30, 31] (Fig. 4). The scrotal pump has two parts, the inflation pump, which presents with an anechoic fluid-filled appearance, and the deflate valve located above the inflation pump, which shows artifacts from their metallic components (Fig. 4).

#### *CT*

Although CT can visualize both MPPs and IPPs, it cannot depict their internal architecture. Moreover, their relative positioning to

**TABLE 1: MRI Sequences in the Evaluation of Penile Prostheses and Their Applications**

MRI Sequence	Application
Coronal large-FOV T2-weighted HASTE	Provides overview of the anatomy and localizes the reservoir and pump
Axial, sagittal, and coronal high-resolution 3-mm T2-weighted TSE images in deflation and inflation	Shows functional and anatomic status of prosthetic components
Coronal high-resolution 3D FSE and TSE sequence with 90° flip-back pulse (optional)	Offers more detailed evaluation of prosthetic components in complicated cases involving repetition of surgery or search for fibrotic plaques
Axial T2-weighted TSE images with fat suppression	Visualizes soft-tissue edema, fluid collection, and macroscopic fat
Axial T1-weighted TSE images	Shows blood products or hematoma
Axial, sagittal, and coronal T1-weighted GRE contrast-enhanced images (optional)	Used for suspected infection and collection
DWI (optional)	Used for suspected infection

Note—TSE = turbo spin-echo, FSE = fast spin-echo, GRE = gradient-recalled echo.

the corpora cavernosa is difficult to observe on CT. CT can be used for evaluation of the pelvic reservoir, prosthetic fracture, and prosthetic infection. Limited CT of the lower abdomen and pelvis is often sufficient for the evaluation of PP, with multiplanar reconstruction used for optimal assessment of positioning of penile cylinders. In our experience, in the assessment of prosthetic infection, contrast-enhanced CT is useful for showing the presence and extent of collection, although no supporting evidence exists in the literature [9]. CT is mainly helpful in the evaluation of the pelvic reservoir, which appears as a round or oval cystic lesion with a hyperattenuated wall and attached thin hyperattenuated tube connecting the reservoir to the scrotal pump [9]. The reservoir is commonly placed behind the rectus abdominis muscle in the perivesical extraperitoneal space anterolateral to the urinary bladder. CT can depict various complications, such as a collapsed reservoir caused by leakage, a calcified irregular nonfunctioning reservoir, and migration into the inguinal canal and other positions [29] (Fig. 5). CT can be used in the quick evaluation of suspected prosthetic infection to show the collection, air pockets, and extent of infection, although CT has the disadvantage of radiation exposure [7].

#### MRI

MRI has now become the imaging modality of choice for the evaluation of PP because of its inherent high soft-tissue contrast, its ability to depict in detail the penile anatomy, and its ability to provide both morphologic and functional assessment of IPP. Also, it is free of ionizing radiation and can image the penile anatomy in three orthogonal planes. MRI can ascertain the optimal positioning of penile cylinders relative to the corpora cavernosa and can show fracture, kinking, and

crossover of the cylinders. It also is useful in the evaluation of the pelvic reservoir and scrotal pump, thereby serving as “one-stop shop” imaging for PP evaluation [7, 8, 32].

**MRI technique**—MRI can be safely performed using either 1.5-T or 3-T MRI scanners, which provide comparable results [33]. Currently available MPPs and IPPs may be safely imaged in 1.5-T systems, except for two MPPs (Omni Phase and Dura Phase, Dacomed) that are not currently marketed because of safety issues [32, 33]. A multichannel phased-array body coil is recommended for better resolution. Appropriate positioning is important for accurate imaging of PPs. The patient needs to be in supine position, and a towel can be placed between the upper thighs to elevate the scrotum and penis. The penis is then placed in an anatomic position on the anterior abdominal wall and is taped to stabilize it. Alternatively, the penis can be placed in a dependent rest position to reduce respiratory artifacts. Soft foam can be kept over the penis beneath the surface coil to avoid near-field artifact [34]. Ideally, MRI should be performed with the PP in both the flaccid and inflated state. The consensus protocol recommended by the Scrotal and Penile Imaging Working Group of the European Society of Urogenital Radiology, including the different MRI sequences and their benefits, is provided in Table 1 [7, 8, 35, 36]. Both contrast-enhanced T1-weighted and DW images currently are optional sequences in the evaluation of prosthetic infection and show the presence and extent of collection. This is based on the European Society of Urogenital Radiology consensus recommendations because, to our knowledge, no supporting literature exists.

**MRI appearance of penile prostheses**—The MPP appears predominantly hypointense

on both T1- and T2-weighted MR images because of the low signal intensity of the silicone cover and their metallic core. Articulating segments in some variants can be identified by their heterogeneous signal. This is important because it is the common site of implant fracture [32] (Fig. 6). IPP is best evaluated on MRI, and the paired inflatable cylinders appear to be homogeneously T2 hyperintense because of their saline content. The silicone-based covering of the cylinders appears T2 hypointense, thereby clearly delineating the cylinders from the surrounding normal corpora [9, 36]. The proximal segment of the cylinders (toward the pubic bone) appears thinner and hypointense because of silicone or polytetrafluoroethylene covering. This is called the rear tip extender, is noninflatable, and is added to maintain stability [25, 37] (Fig. 7). In addition to evaluating the cylinders, MRI can also depict other penile structures, including the corpora spongiosa, urethral integrity, and the status of the tunica albuginea.

The pelvic reservoir is usually placed anterolateral to the urinary bladder in the perivesical space. It appears as a T2-hyperintense round or oval cystic lesion with a thin T2-hypointense wall adjacent to the urinary bladder. A small connecting tube can be seen as a linear hypointense structure along one of the walls. A scrotal pump is placed in the subdartos pouch posteroinferiorly between the testes. It appears as small T2-hyperintense oval structure with metallic artifacts at one end representing the check-valve apparatus. All three components are connected by thin silicone tubing, which appears as a T2-hypointense tubular structure [31, 34].

#### Pitfalls

Inflatable cylinders can appear deformed, mimicking buckling in the deflated state.

Most cylinder positioning abnormalities, including crossover, erosion, proximal migration, and aneurysm, are better seen on images of cylinders in an inflated state and can even be overlooked on images of cylinders in a deflated state. Hence, all abnormalities should be confirmed on images of cylinders in an inflated state [8, 34] (Fig. 8).

It is a common pitfall to mistake the PP reservoir for a pelvic collection or bladder diverticulum or even for the urinary bladder in cases of empty urinary bladder [30, 31]. Identification of the echogenic structure representing a check-valve on sonography, in addition to the silicone tubing, can be helpful in avoiding this pitfall [38] (Fig. 9). The radiologist should also be aware of this pitfall and needs to be proactive in obtaining the history of PP surgery because both the referring urologists and the patients may not be forthcoming.

## Conclusion

As a result of technologic advances and ease of availability, imaging is now commonly used in the evaluation of PP. It is important for radiologists to be aware of the various types of PP and their normal appearance in different imaging modalities. Two major types of PP—MPP and IPP—are available. The imaging appearance varies depending on the type of PP and the imaging technique used. Although radiography, sonography, and CT can show the different components of PP, MRI is the best technique overall for the complete evaluation of PP. Radiologists should be familiar with the MRI protocol, techniques for acquisition including deflated and inflated phases, and the common pitfalls for accurate diagnosis and optimal management.

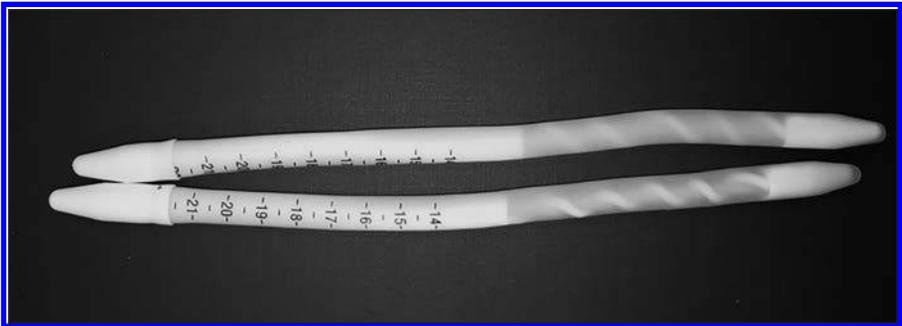
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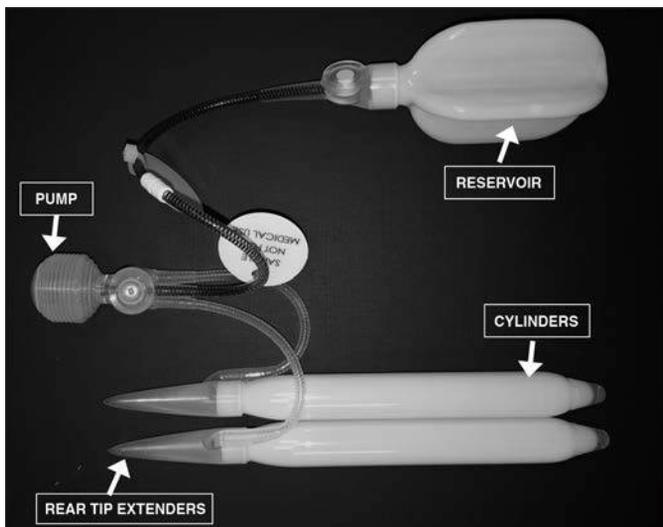
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**Fig. 1**—Photograph of malleable penile prosthesis showing paired penile cylinders.



**Fig. 2**—Photograph of three-piece inflatable penile prosthesis. Three components (paired penile cylinders, reservoir, and scrotal pump) are shown with interconnecting tubes.



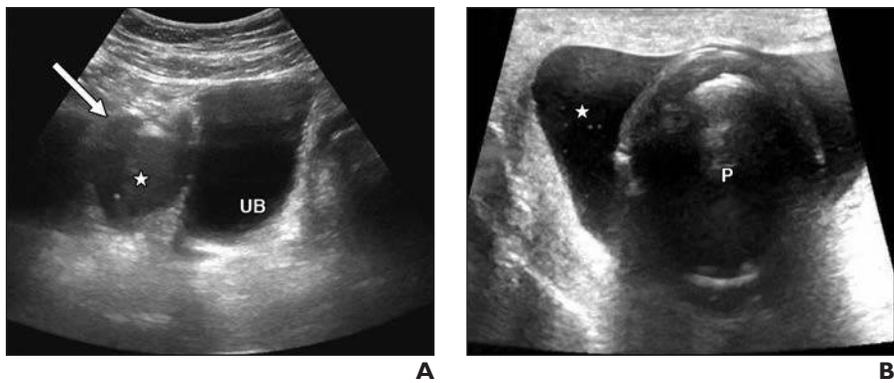
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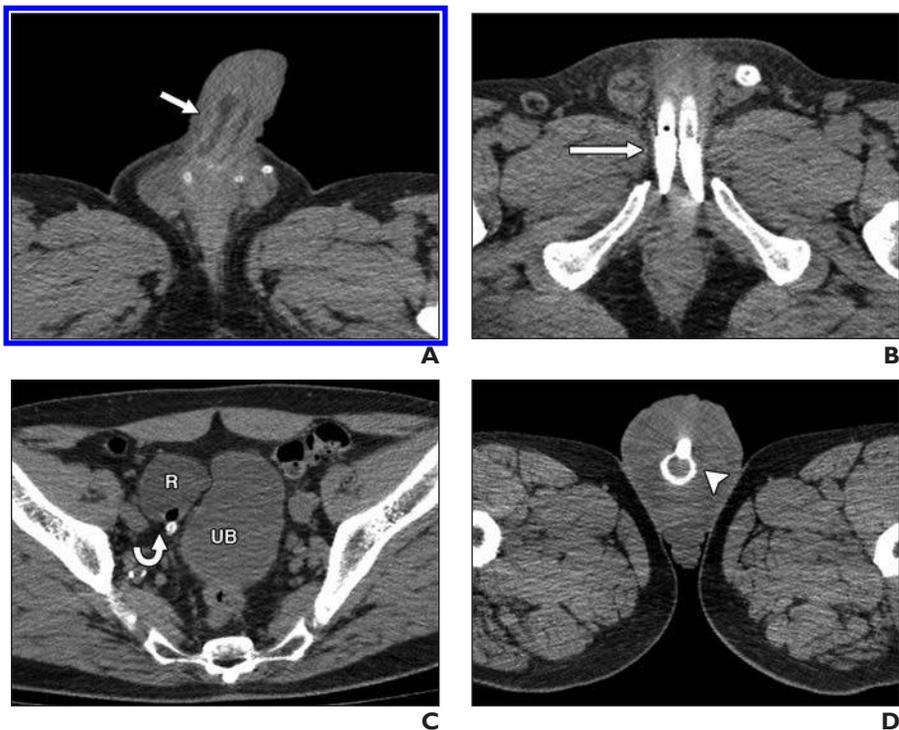
**B**

**Fig. 3**—Two men with penile prostheses shown on radiography.  
**A**, 60-year-old man with malleable inflatable penile prosthesis. Radiograph shows paired braided metallic cylinders of malleable penile prosthesis (*arrowhead*). Surgical clips in pelvis from prior radical prostatectomy and metallic component (valve) of scrotal pump for artificial urinary sphincter are also seen (*arrow*).  
**B**, 70-year-old man with inflatable penile prosthesis. Radiograph shows metallic component (rear tip extender) of inflatable penile prosthesis (*arrowhead*) located in posterior part of corpora cavernosa. Rest of penile cylinders are saline filled and are not radiopaque. Metallic component (valve) of scrotal pump is also seen (*arrow*).

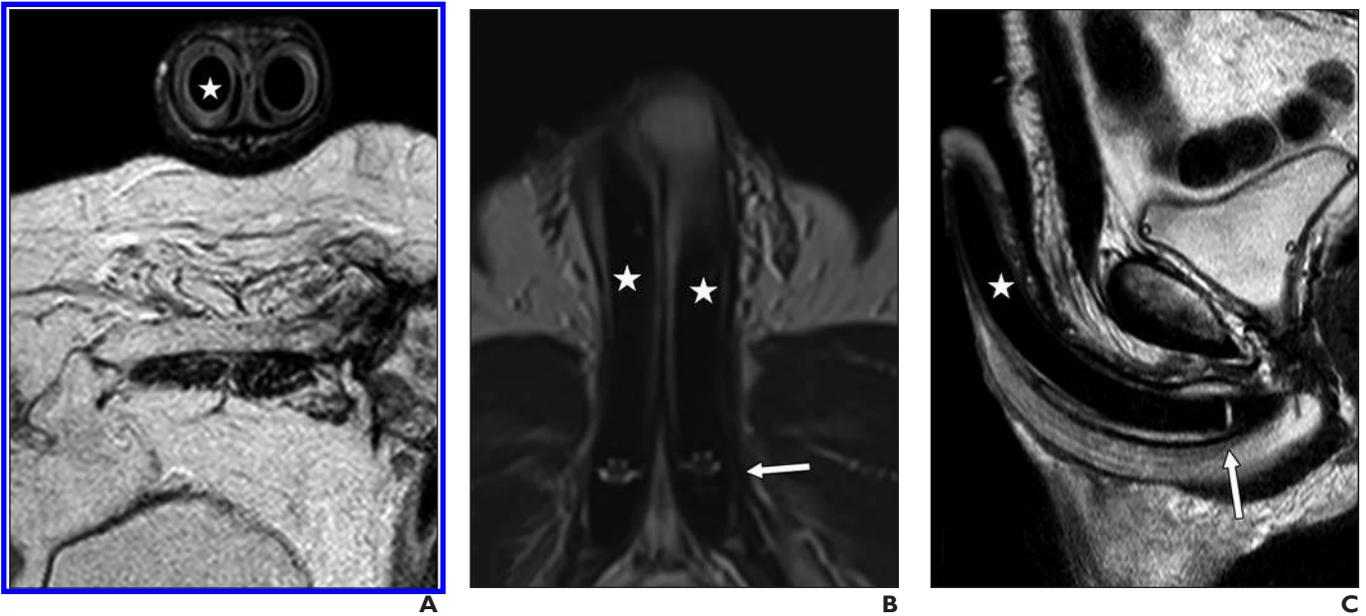
### Imaging of Penile Prostheses



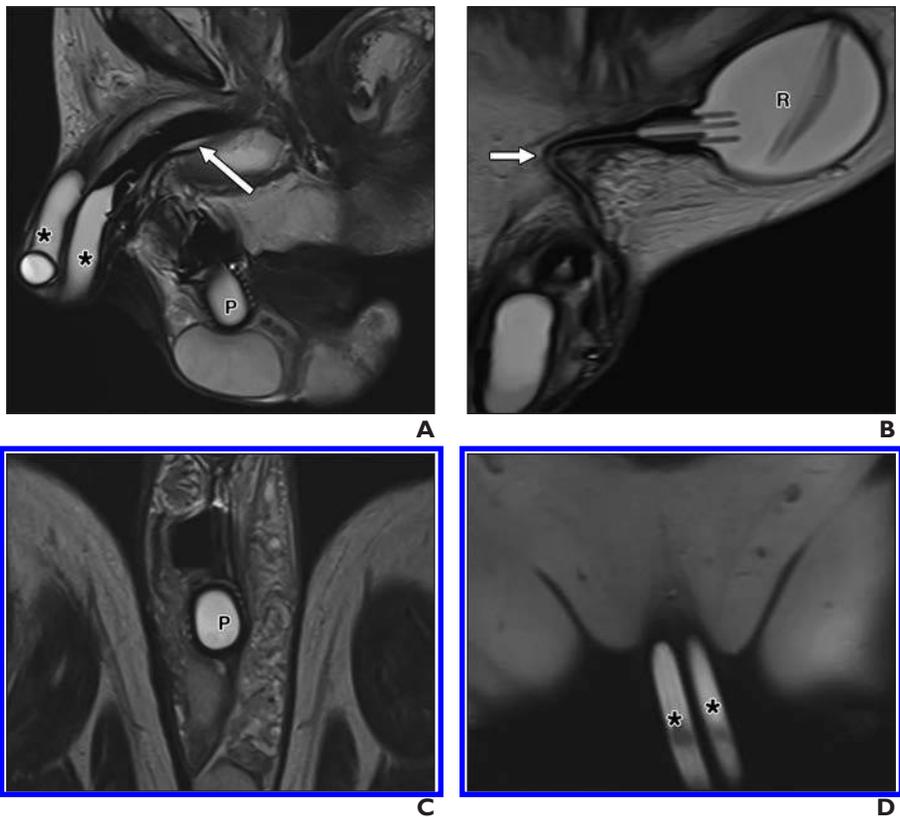
**Fig. 4**—55-year-old man with inflatable penile prosthesis shown on sonography. **A**, Ultrasound image of pelvis shows round cystic structure (*arrow*) adjacent to urinary bladder (UB) with internal reverberation artifacts from check-valve apparatus (*star*), representing pelvic reservoir. **B**, Ultrasound image of scrotum shows scrotal pump (P) as round cystic structure with reverberation artifacts from check-valve apparatus along with surrounding fluid in tunica vaginalis (*star*).



**Fig. 5**—62-year-old man with inflatable penile prosthesis shown on serial axial CT sections. **A** and **B**, Axial CT sections of pelvis show partially inflated fluid-filled penile cylinders (*arrow*, **A**) and metallic rear tip extenders (*arrow*, **B**). **C**, Axial CT section of pelvis shows pelvic reservoir (R) adjacent to urinary bladder (UB) with check valve (*arrow*). **D**, Axial CT section of pelvis shows scrotal pump (*arrowhead*).

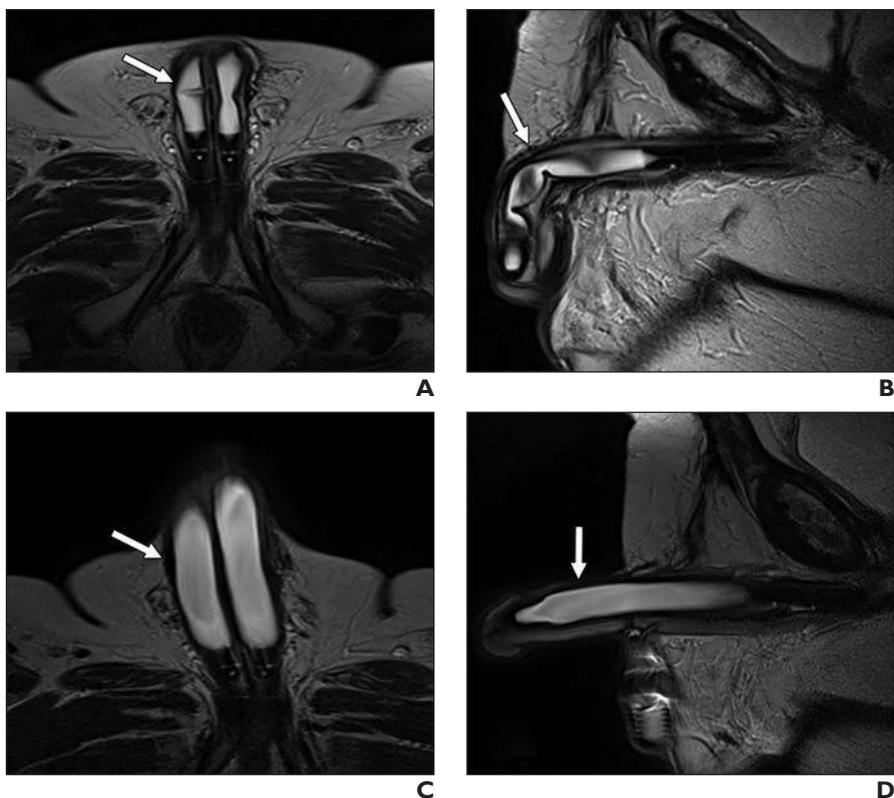


**Fig. 6**—58-year-old man with malleable penile prosthesis shown on MRI. **A–C**, Axial (**A**), coronal (**B**), and sagittal (**C**) T2-weighted MR images show paired T2 hypointense noninflatable malleable penile prosthesis cylinders (*stars*) in corpora cavernosa. Arrows in **B** and **C** indicate articulating segments.

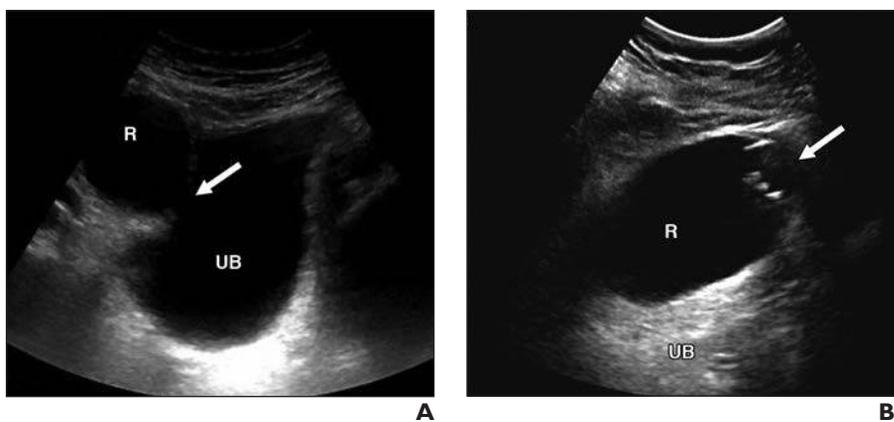


**Fig. 7**—52-year-old man with inflatable penile prosthesis shown on MRI. **A–D**, Sagittal (**A**), coronal (**B**), axial (**C**), and coronal (**D**) T2-weighted MR images show paired T2 hyperintense saline-filled inflatable penile prosthesis cylinders (*asterisks*) in corpora cavernosa, metallic T2 hypointense rear tip extenders (*arrow*, **A**), interconnecting tubes (*arrow*, **B**), subcutaneously placed left inguinal reservoir (**R**), and scrotal pump (**P**).

### Imaging of Penile Prostheses



**Fig. 8**—60-year-old man with inflatable penile prosthesis (IPP). Pitfall of imaging IPP in deflated state is shown. **A** and **B**, Axial (**A**) and sagittal (**B**) T2-weighted MR images show buckled and deformed appearance of saline-filled IPP cylinders in deflated state (*arrow*). **C** and **D**, Axial (**C**) and sagittal (**D**) T2-weighted MR images show correction of buckling after inflation of IPP cylinders, indicating normal functioning of penile prosthesis (*arrow*).



**Fig. 9**—72-year-old man with inflatable penile prosthesis. Pitfall of imaging pelvic reservoir is shown. **A**, Gray-scale ultrasound image shows cystic structure (R) adjacent to urinary bladder (UB) with appearance of communicating with UB, raising possibility of bladder diverticulum (*arrow*). **B**, Image from repeat focused ultrasound examination performed after bladder was emptied shows persistence of cystic structure (R) with reverberation artifacts along its wall (*arrow*). Cystic structure was confirmed as pelvic reservoir of inflatable penile prosthesis after discussion with patient and referring urologist.

#### FOR YOUR INFORMATION

The reader's attention is directed to a related article, titled "Comprehensive Multimodality Imaging Review of Complications of Penile Prostheses," which begins on page 1200.

**This article has been cited by:**

1. Cristina Gómez Varela, Lucía A. Mateos Yeguas, Iria Couto Rodríguez, María D. Durán Vila. 2020. Penile Doppler Ultrasound for Erectile Dysfunction: Technique and Interpretation. *American Journal of Roentgenology* **214**:5, 1112-1121. [[Abstract](#)] [[Full Text](#)] [[PDF](#)] [[PDF Plus](#)]